



Pesticide Science Fund Research in the *Atlantic Region*

The Governments of Canada and Prince Edward Island are working with the agricultural community to assess and reduce risks associated with pesticide use. Pesticides are used more intensively in Prince Edward Island than in any other province in Canada. As a result, it has a unique set of challenges when it comes to pesticide use.

In 2003, Environment Canada's Atlantic Region office began an expanded Pesticide Research and Monitoring Program, which is the most comprehensive regional program of its kind to date. The monitoring part of this program measures pesticide residues in groundwater, surface water, sediment, air, and aquatic biota, including finfish and shellfish. The research program evaluates both the environmental risks associated with pesticide use and the methods that can reduce those risks.

This technical sheet provides a summary of the results of the first three-years of a six year research program on pesticides in potato growing areas, which was supported by Environment Canada's Pesticide Science Fund. A separate summary of the pesticide monitoring program is available.

Research Program

The research component of the Pesticide Science Fund effort is aimed at assessing the risk to aquatic species, such as fish and aquatic invertebrates, from the use of pesticides in potato agriculture. The research was also used to determine the principal factors affecting their transport to, and effects in, aquatic systems. Ultimately, this research will be used to develop methods to reduce the environmental risk posed by such pesticide use. Results of this research are provided to the public, provincial regulatory agencies, the Pest Management Regulatory Agency and agricultural agencies at the federal and provincial level in order to promote implementation of mitigative measures. The research is highly collaborative, including participation by scientists from Environment Canada, Agriculture and Agri-Food Canada, the PEI Department of Agriculture, Fisheries and Aquaculture and members of the Bedeque Bay Environmental Management Association.

Conducted in potato growing areas of Prince Edward Island and New Brunswick, the aims of this research projects are to:

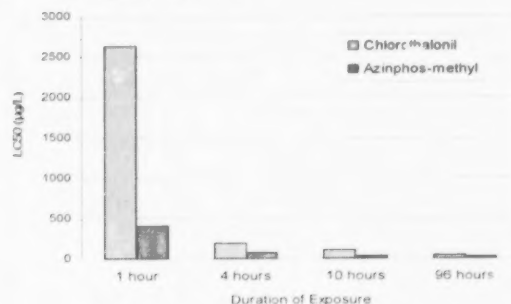
- assess the short-term toxicity of potato pesticides to aquatic organisms
- assess the pesticide concentrations in runoff, as well as pesticide fate and effects in aquatic systems
- determine the effectiveness of riparian buffer zones in reducing the pesticide concentrations and toxicity of runoff from potato fields
- determine the runoff characteristics of various farming practices
- measure concentrations of pesticides in air near sprayed fields

While the research is not completed at this time, some early results are presented below:

Short Term Toxicity

Short-term toxicity is measured by looking at the concentration of pesticide that is lethal to 50% of the organisms under study. Thus, in Figure 1, the higher bars signify less toxicity. The work is showing

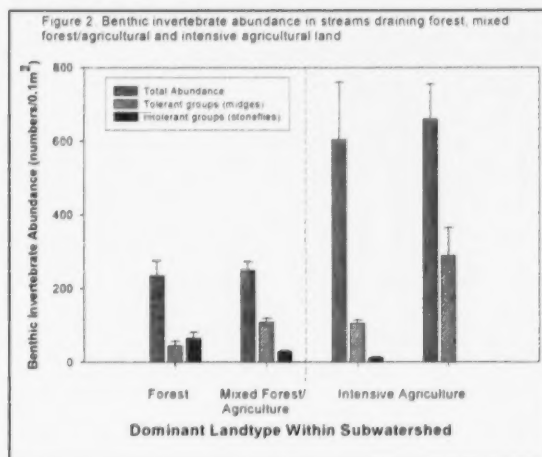
Figure 1 Toxicity of azinphos-methyl and chlorothalonil to Rainbow trout for different lengths of exposure



that during a typical pesticide exposure regime, the longer the exposure the greater the toxicity. Different pesticides have different toxic potentials and the fungicide chlorothalonil is less toxic than the insecticide azinphos-methyl at shorter exposures (Figure 1). In other pesticide toxicity tests (not shown) it was demonstrated that toxicity to aquatic organisms is not substantially reduced by the addition of soil particles, indicating that most of the toxicity resides in the dissolved form. Some tests showed irreversible effects (immobility or paralysis) at concentrations very much lower than those shown to be immediately lethal, which may indicate that observance of guidelines which are based on lethal data may not be sufficiently conservative.

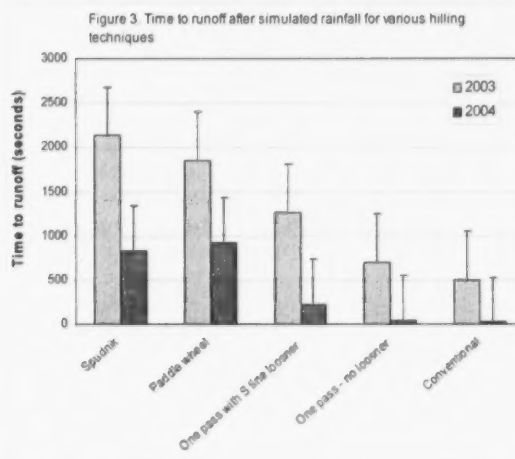
Aquatic Invertebrate Effects

Benthic invertebrates such as mayflies, stoneflies and midges are commonly used as indicators of environmental conditions in freshwaters. Studying their types and abundance in our streams gives us an indication of ecosystem health. The research shows that changes in land use (ranging from forested to intensive agriculture) correlate with increased invertebrate abundance (Figure 2). This suggests that nutrients derived from agricultural lands increase stream productivity, a trend that is most evident for pollution tolerant invertebrates such as midges. Pollution intolerant invertebrates, including stoneflies, are less abundant in intensely farmed areas. Investigations are continuing to establish whether this reduced abundance of intolerant invertebrates is due exclusively to nutrient enrichment or whether pesticide contamination also plays a role.



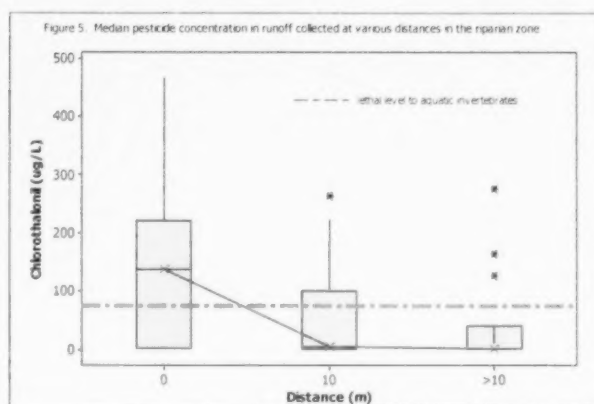
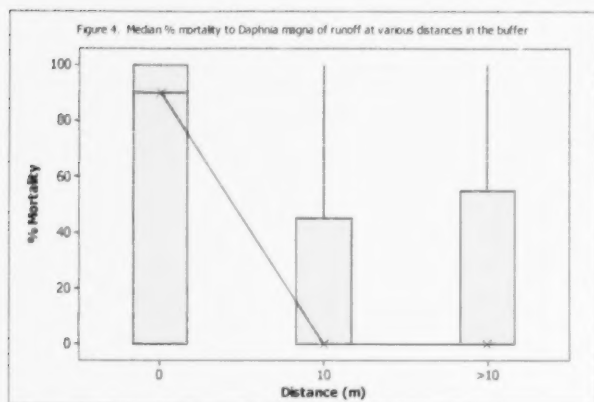
Cultural Practices

Investigations of different cultural practices were conducted to compare the effects of various hilling techniques on soil and water retention. It is preferable that the pesticide "time to runoff" or that time taken for a pesticide to leach to a water body (stream, river, lake), be as long as possible. Time to runoff and soil loss was evaluated using a portable rainfall simulator. One pass hillers equipped with a paddle wheel loosener and the commercially available Spudnik were shown to significantly improve (increase) the time to runoff compared to conventional hilling techniques (Figure 3).



Riparian/Buffer Effectiveness

There has been considerable effort directed at determining the effectiveness of the PEI-legislated 10-metre riparian buffer zones. This legislation aims to reduce pesticide concentrations and toxicity to aquatic life from agricultural runoff. Results to date indicate that the riparian strips are able to reduce runoff toxicity (Figure 4) and pesticide concentrations but not always to non lethal levels for aquatic species (Figure 5). The smaller data set and associated uncertainty for buffer zones greater than 10 metre makes it difficult to ascertain the effectiveness of wider buffer strips. Future work will focus on building the data set beyond 10 metres to determine the appropriateness of 20-metre buffers required for steeper sloped fields.



Pesticides in Air Near Fields

Due to high agricultural activity, it is not surprising that studies conducted in PEI indicate that pesticides are present in the air in at least low concentrations at all times of the day even in locations which are not near agricultural areas. Chlorothalnil is the pesticide measured most frequently and in the highest concentrations. All concentrations were found to be below concentrations that are expected to have effects on birds or mammals.

Figure 6 shows the maximum and average concentrations of chlorothalnil measured compared to US guidelines for 1 hour and 24 hour exposure. The USEPA Annual Air Quality Guideline is $0.6 \mu\text{g}/\text{m}^3$. No Canadian guidelines exist.

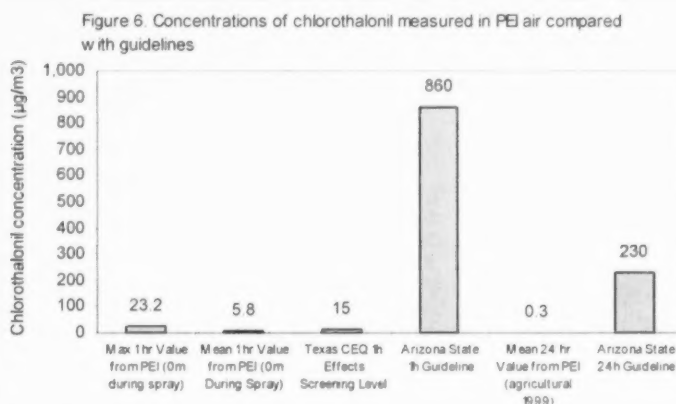
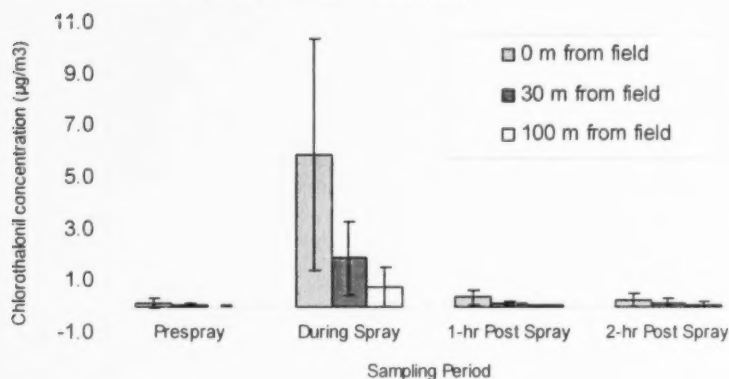


Figure 7: Mean concentrations of chlorothalnil measured in air near sprayed potato fields (1hr samples)



Current work is focussed on determining pesticide concentrations in air near sprayed potato fields in an effort to determine the amount of pesticide that might be inhaled by birds and mammals near those operations. These data are used in wildlife risk assessments.

The research also aims to determine how airborne concentrations are affected by meteorological conditions in order to better understand pesticide movement in the air. Figure 7 shows the concentrations that have been measured at different times and different distances from a sprayed field.

Summary

Data generated through this program will help to:

- Gain knowledge on priority in-use pesticide short-term toxicities; separating the effects of nutrients from pesticides on aquatic invertebrate communities
- Understand the effectiveness of cultural practices on water retention; adding to the database on buffer zones
- Test models that predict runoff under various conditions; applying this knowledge to best management practices

The combined results of this work are currently being prepared for publication in scientific journals. The following publications and presentations provide additional information on this research and are available by calling Environment Canada at 902-426-5048, or by e-mail at bill.ernst@ec.gc.ca

Publications and Presentations

- Denning, A., W. Ernst, G. Julien, K. Doe, A. Cook, M. Bernier, P. Jackman and C. Losier. 2004. An assessment of buffer zone effectiveness in reducing pesticide runoff from potato fields in Prince Edward Island (2001-2002). EPS-5-AR-04-05. ISBN 0-662-37661-7.
- Denning, A., K. Doe, A. Cook, B. Ernst, G. Julien. 2004. An assessment of the effectiveness of 10 m buffer zones in minimizing pesticide runoff from potato fields in Prince Edward Island (2003). Presented at the 31st Aquatic Toxicity Workshop, Oct. 24-27, 2004, Charlottetown, PEI. In: Canadian Technical Report of Fisheries and Aquatic Sciences 2562 (Editors L.E. Burridge, K. Haya, and A.J. Niimi).
- Dunn, A.M., W.R. Ernst, M. Bernier, A. Cook, K.G. Doe, P.M. Jackman and G. Julien. 2005. Evaluation of buffer zone effectiveness in the protection of aquatic environments in Prince Edward Island – 2004. Presented at the 32nd Annual Aquatic Toxicity Workshop, October 3 to 5, 2005, Waterloo, Ontario. In: Canadian Technical Report of Fisheries and Aquatic Sciences 2617 (Editors D.G. Dixon, S. Munro and A.J. Niimi).
- Dunn, A.M., G. Julien, W.R. Ernst, A. Cook, K.G. Doe, and P.M. Jackman. 2006. Evaluation of buffer zone effectiveness in mitigating the risks of agricultural runoff in Prince Edward Island. Presented at the 12th Annual Society of Environmental Toxicology and Chemistry North Atlantic Chapter Meeting, June 7 to 9, 2006, Portland, Maine.
- Dunn, A.M. 2006. Validation of surface runoff models using measured pesticide concentrations in agricultural runoff. Presented at the 27th Annual Society of Environmental Toxicology and Chemistry North America Meeting, November 5-9, 2006, Montréal, Québec.
- Jackman, P.M. and K.G. Doe. 2004. Toxicity of pesticides in short-term exposures. Presented at the 31st Annual Aquatic Toxicity Workshop, October 24 to 27, 2004, Charlottetown, PEI. In: Canadian Technical Report of Fisheries and Aquatic Sciences 2562 (Editors L.E. Burridge, K. Haya, and A.J. Niimi).

